Overview and recent results from KiDS

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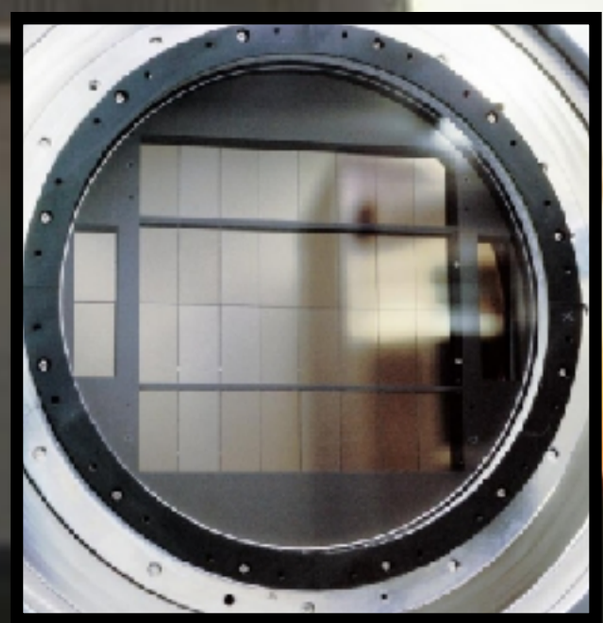
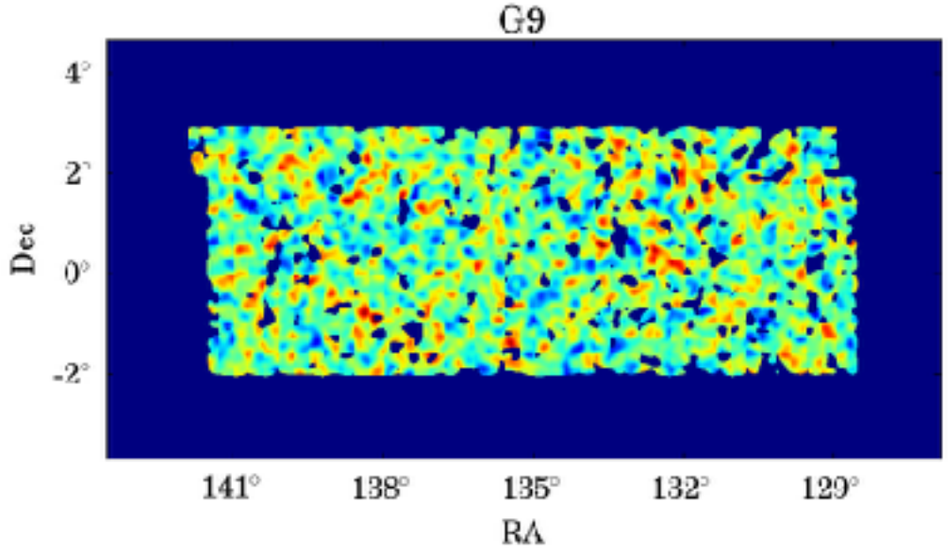
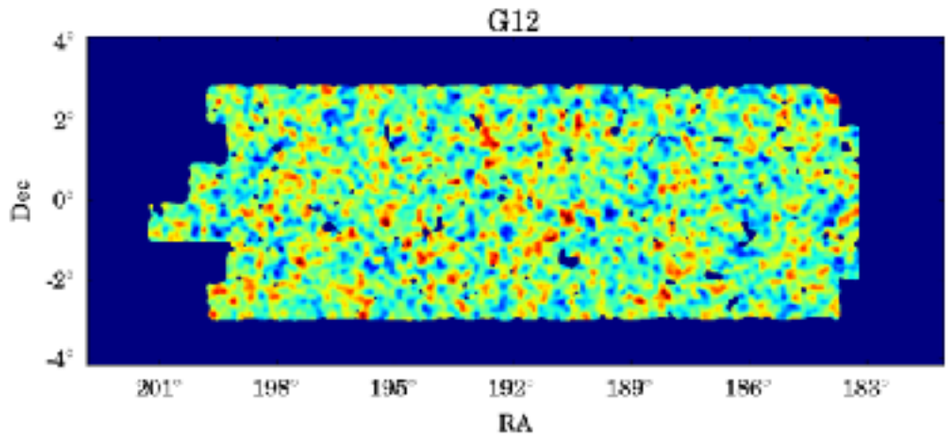
KiDS

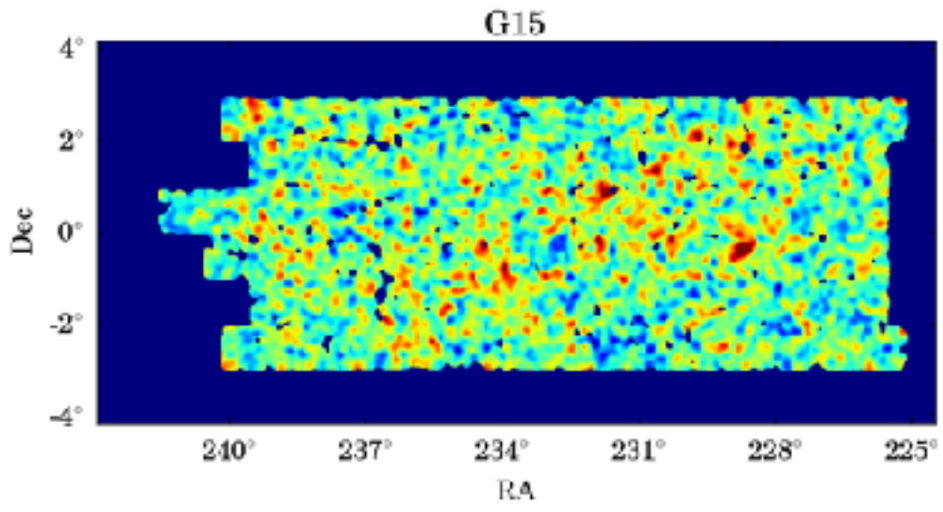
- 1500 sq. deg. survey
- VLT Survey Telescope (VST)
- Four bands: *ugri*
- Shapes down to r~24
  ~8 gal/arcmin^2
- Overlap with VIKING
  (ZYJHKs)

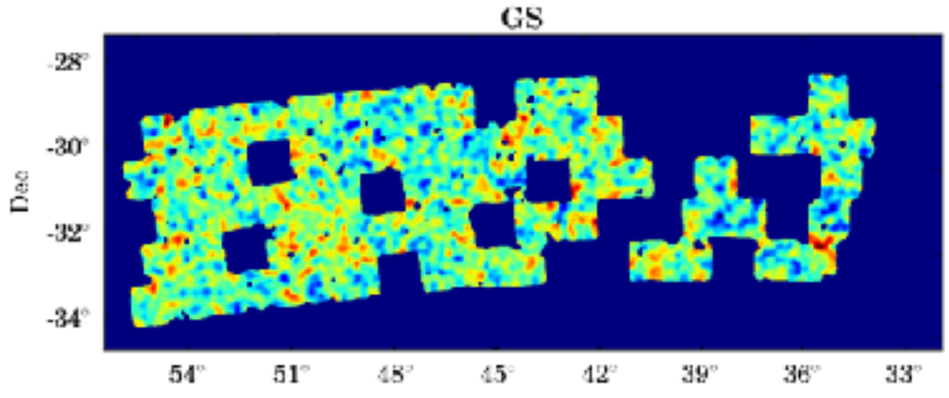


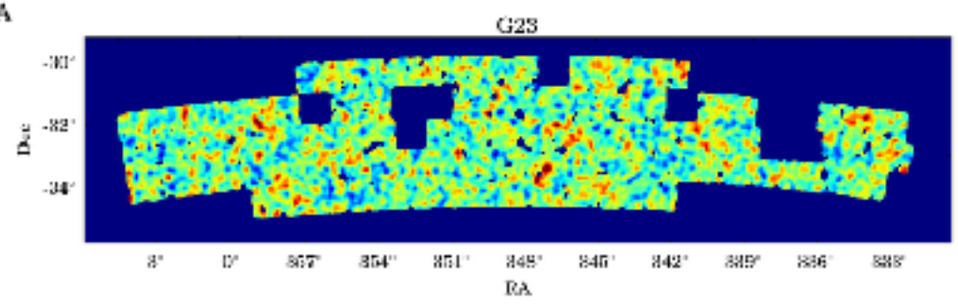
Cosmic shear with KiDS-450









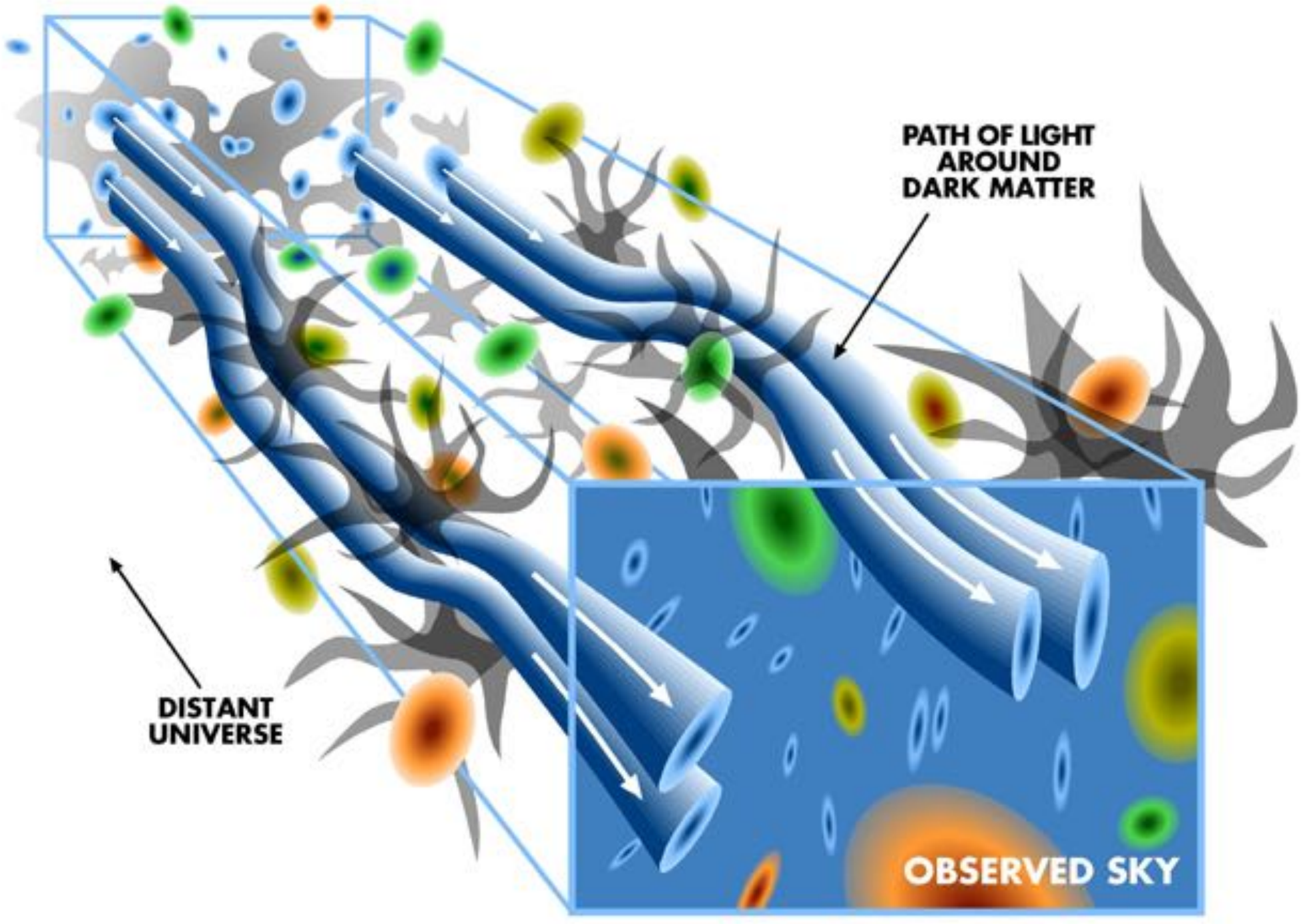


- 450 deg^2 (observations up to July 2015).

- Tomographic analysis: 4 photo-z slices
  $0.1<z_{phot}<0.3$, $0.3<z_{phot}<0.5$,
  $0.5<z_{phot}<0.7$, $0.7<z_{phot}<0.9$

KiDS

Hildebrandt, Viola et al. (2017)

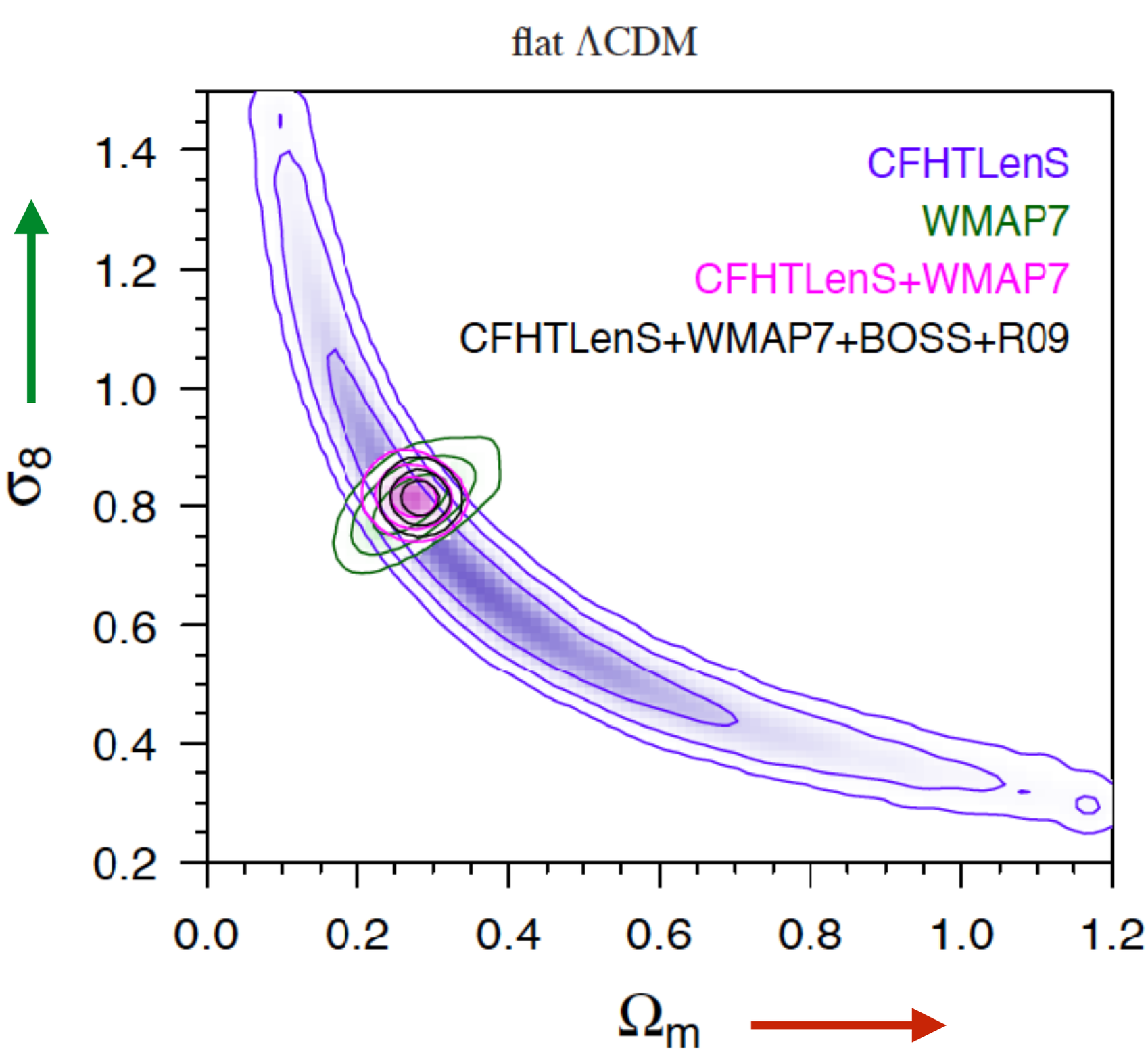


Cosmic shear

$$\epsilon = \epsilon^{(s)} + g$$

$$\langle \epsilon \rangle = \left\langle \epsilon^{(s)} \right\rangle + \langle g \rangle = \langle g \rangle$$

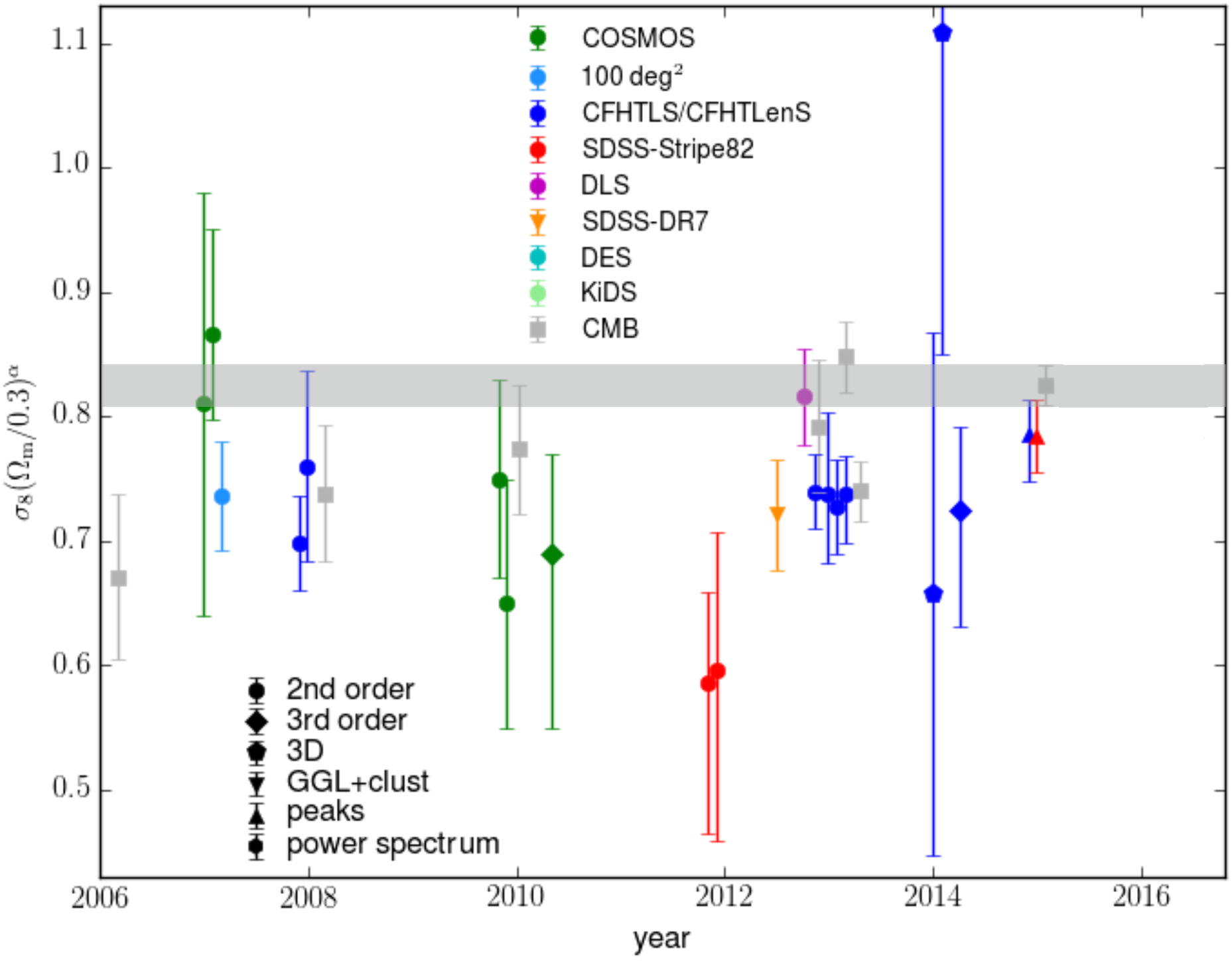
Credit: LSST



- Measure **amount** of **clustered** matter
- $S_8 = \sigma_8 (\Omega_m/0.3)^{0.5}$

Cosmological constraints

Kilbinger et al. (2013)



S_8 results over the years

Kilbinger (2015)

Systematic error control

- Shape measurement systematics:
  - Telescope/camera design (Cassegrain focus)
  - Thin CCDs (no brighter-fatter effect)
  - Observing conditions

- Photo-z systematics:
  - Survey design (shallow and wide)
  - **NEW:** VIKING overlap 5 NIR bands

- Theoretical systematics:
  - State-of-the-art analysis tools & Redundancy
  - Avoid angular ranges with large model uncertainties

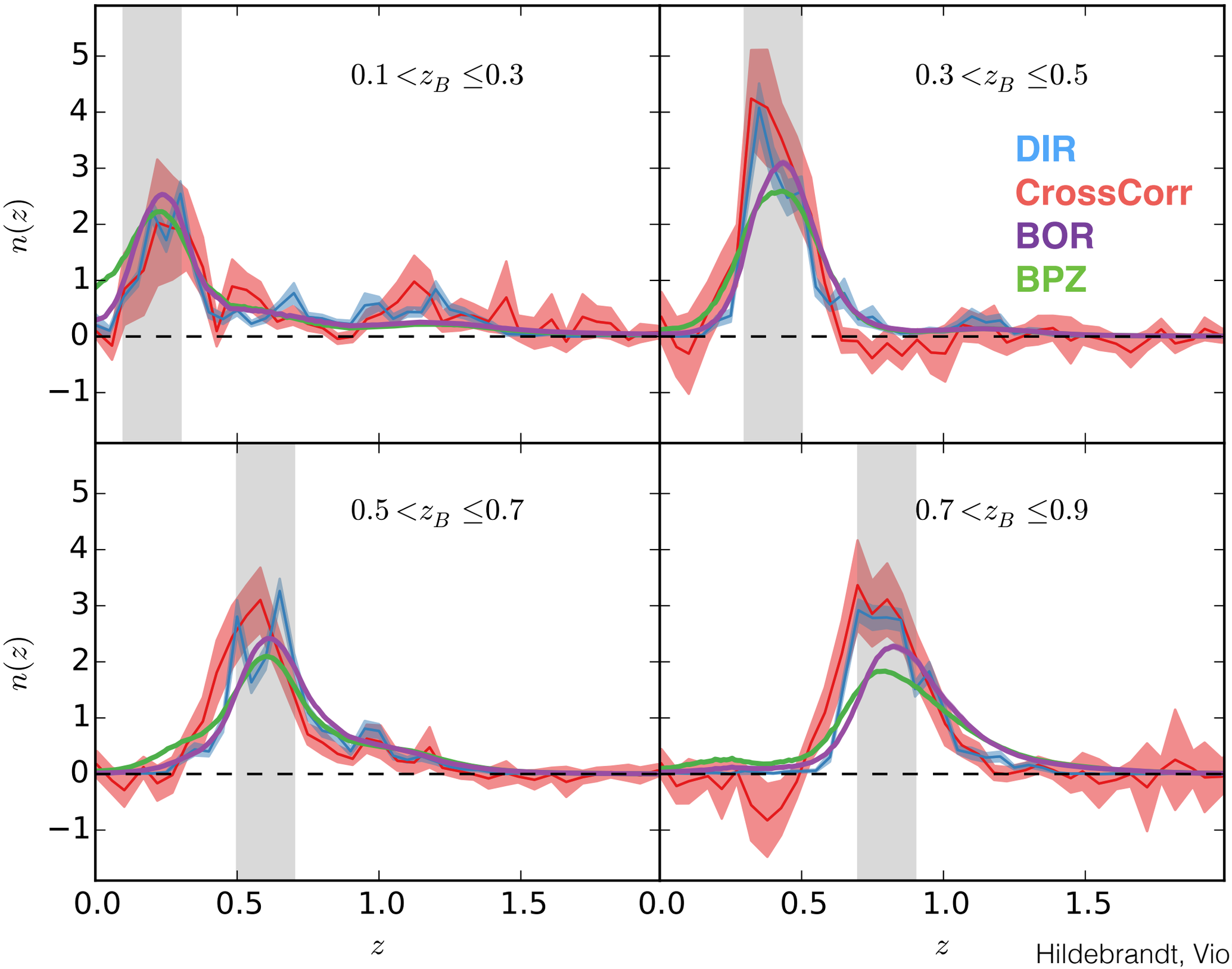
- Psychological systematics:
  - Blinding

Shear calibration

- New *lens*fit code ‘self-calibrates’ noise bias
- Image simulations with realistic PSFs, dithers, noise, crowding, chip gaps, etc.
- Match *observed* size, ellipticity, SNR distributions in each tomographic bin
- Residual calibration factor is 1-2% ±0.2%.

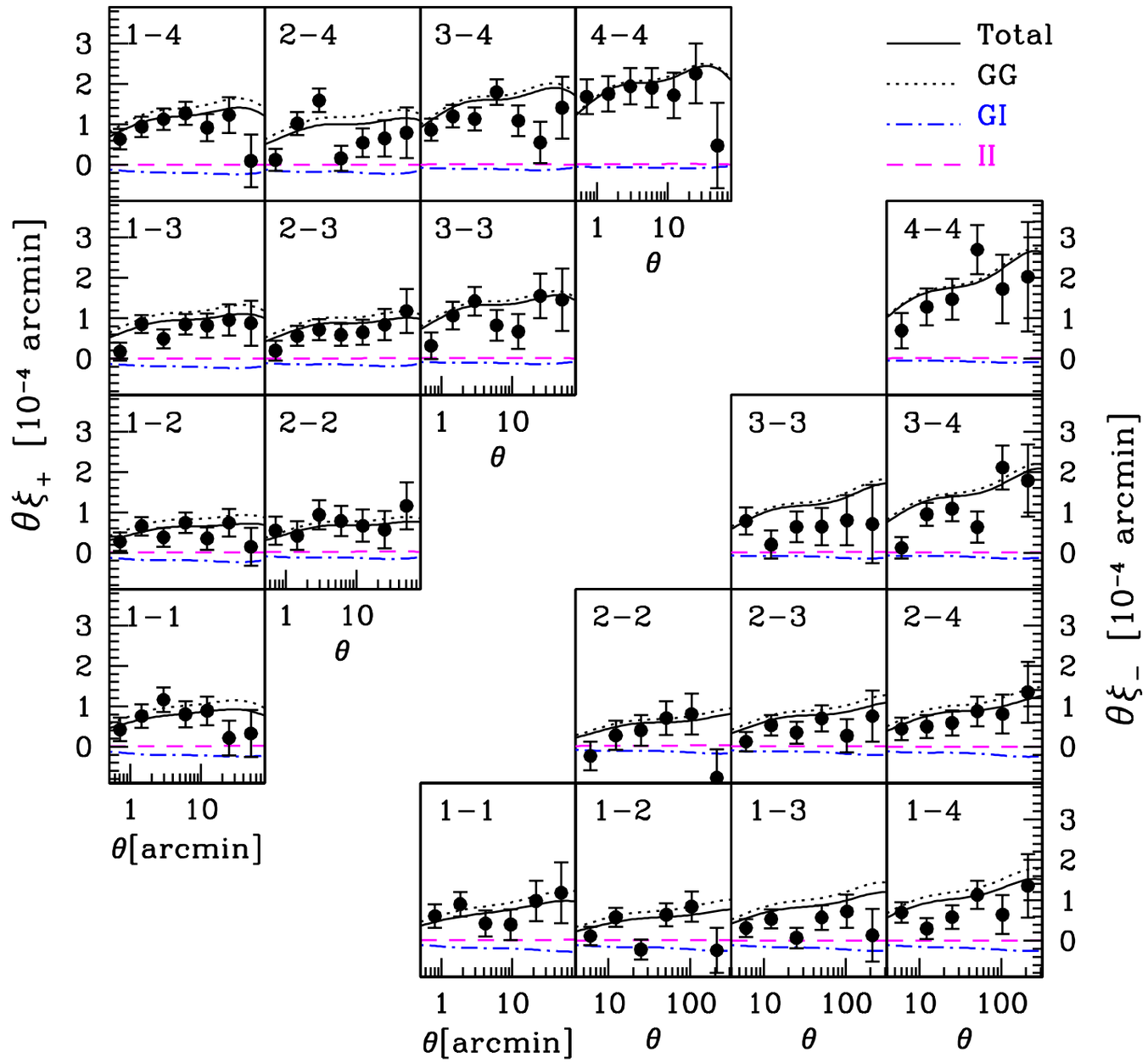
Fenech Conti et al. 2016

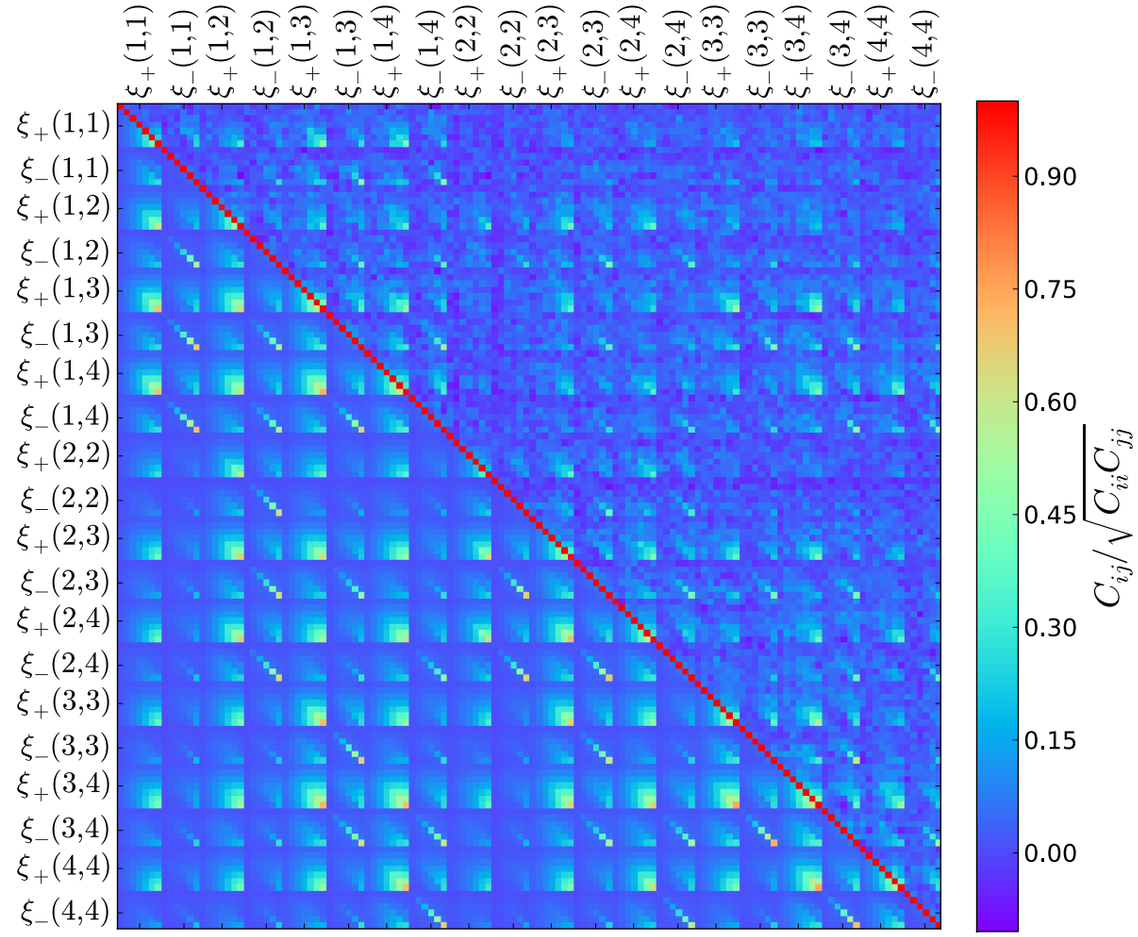
Photo-z calibration



Hildebrandt, Viola et al. (2017)

Data vector

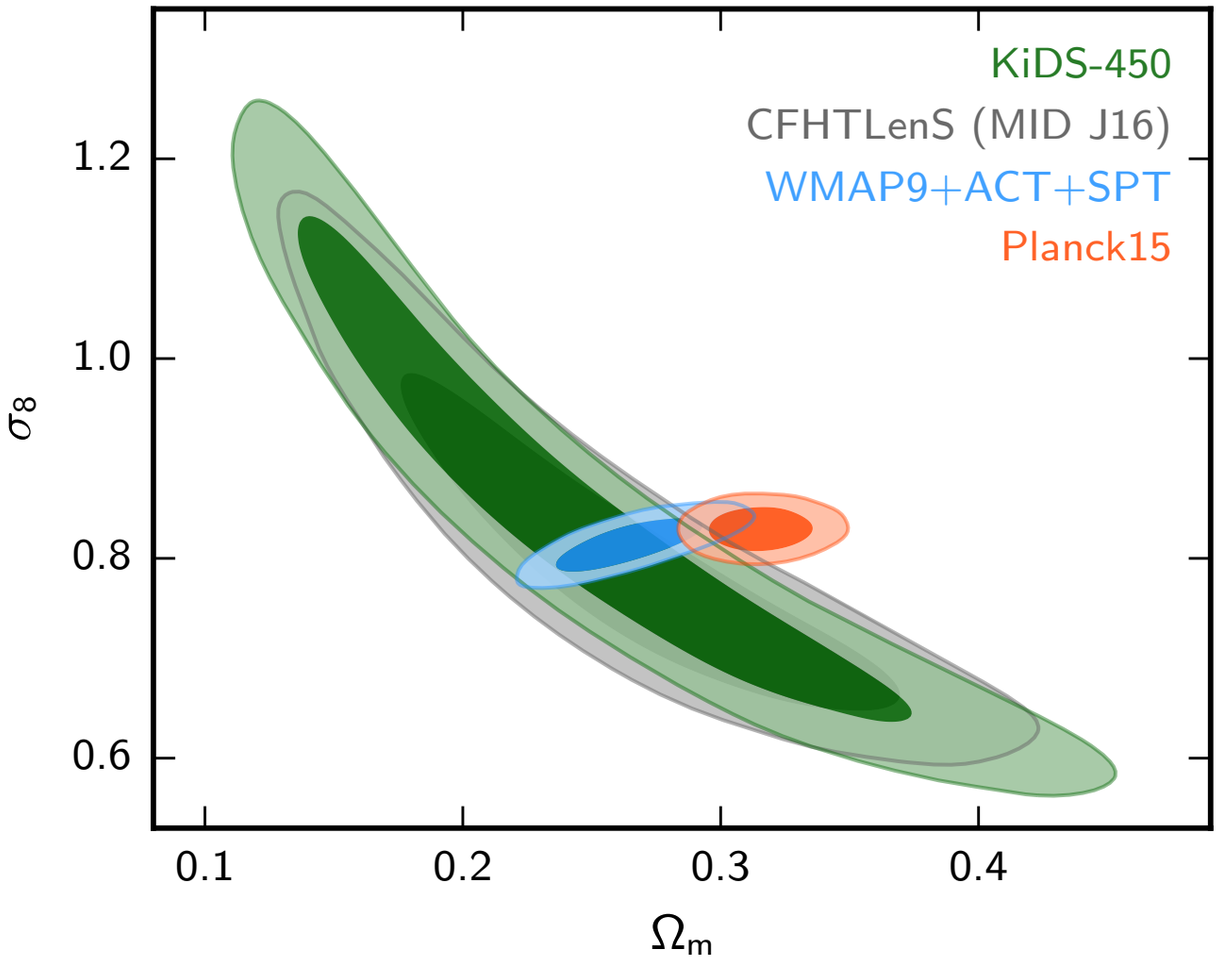


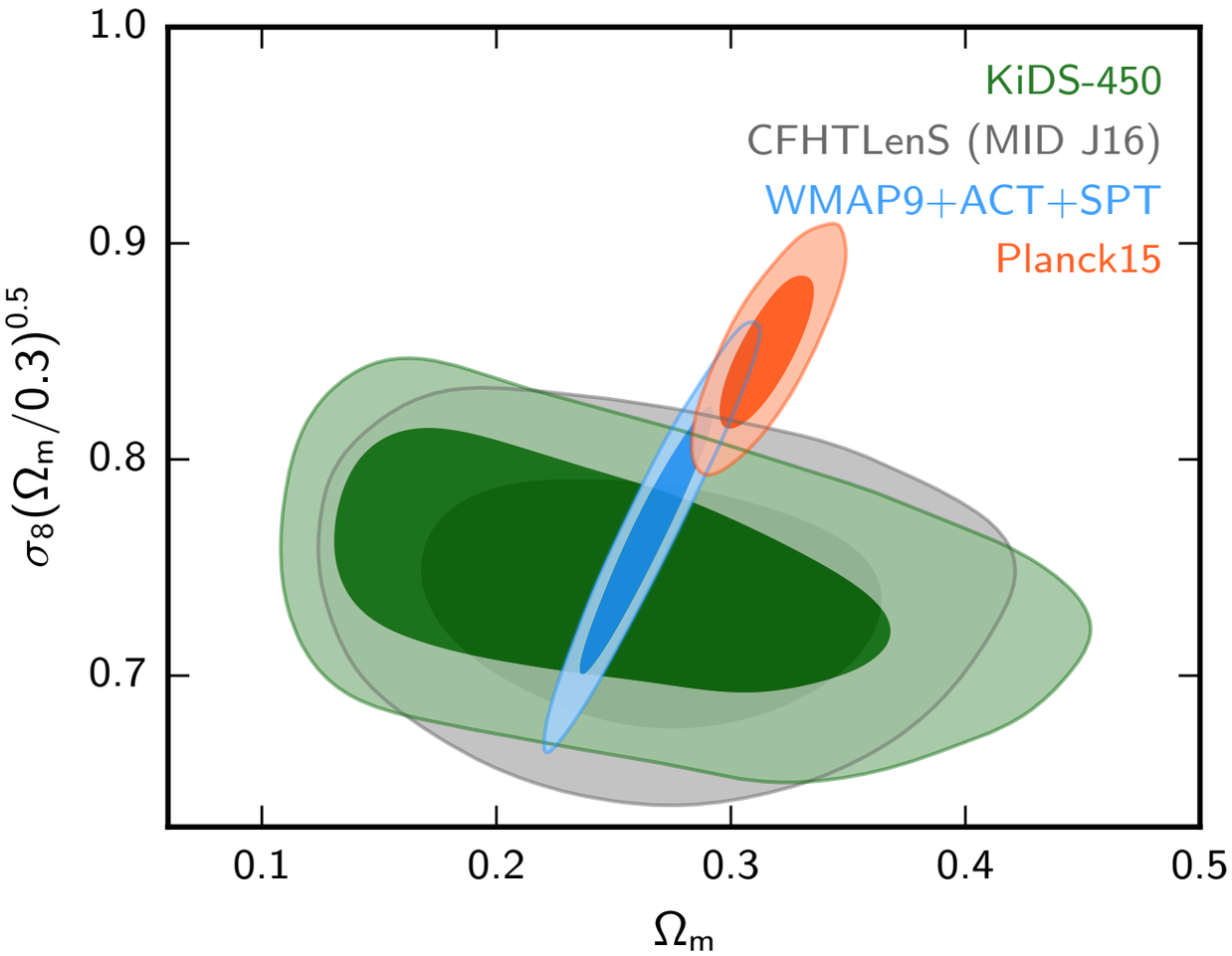


- 130 points from shear-shear correlation functions ξ_+, ξ_-.
- pick radial ranges to avoid small-scale model systematics and large-scale shear systematics

Hildebrandt, Viola et al. (2017)

KiDS-450: Results (blind-1)

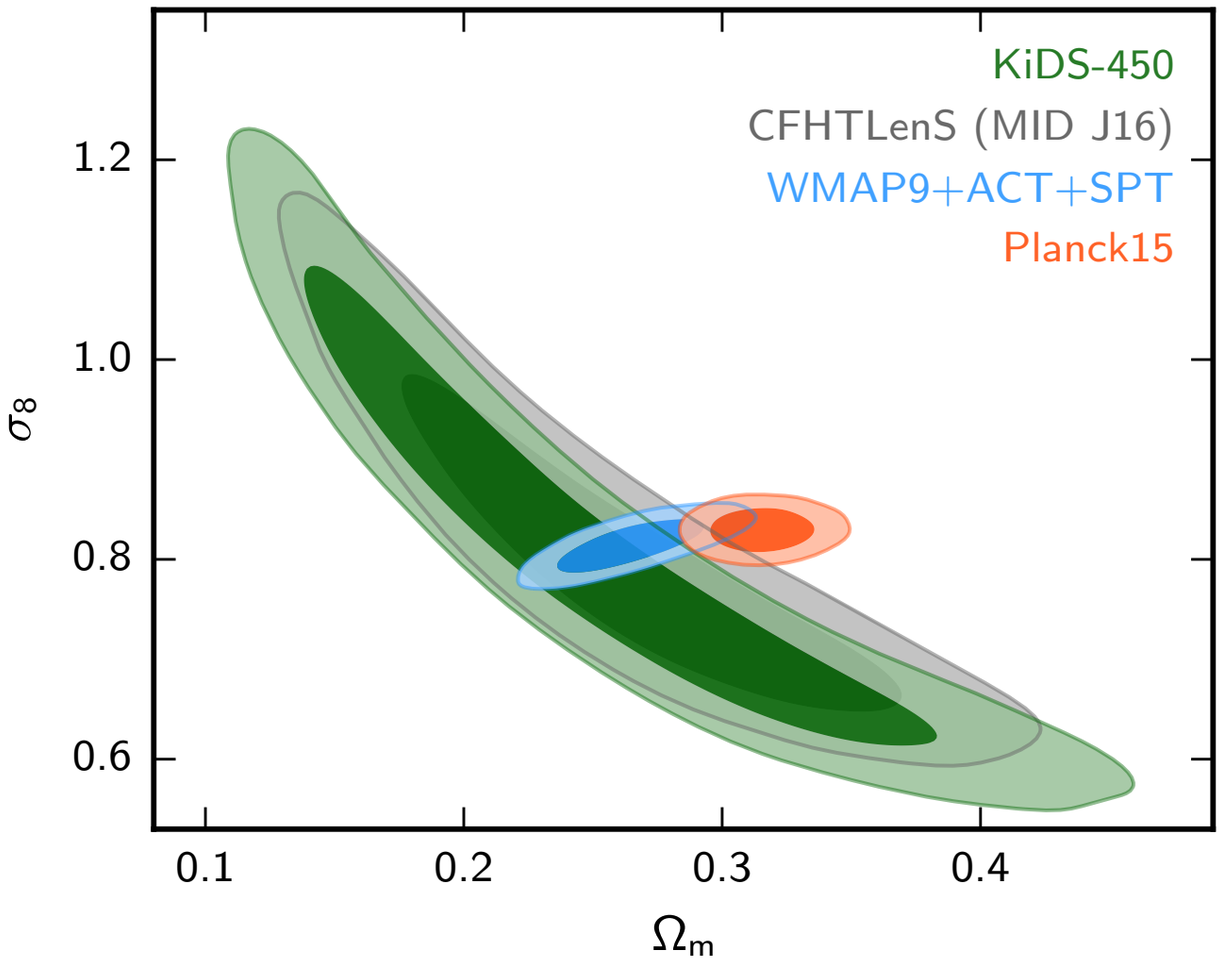


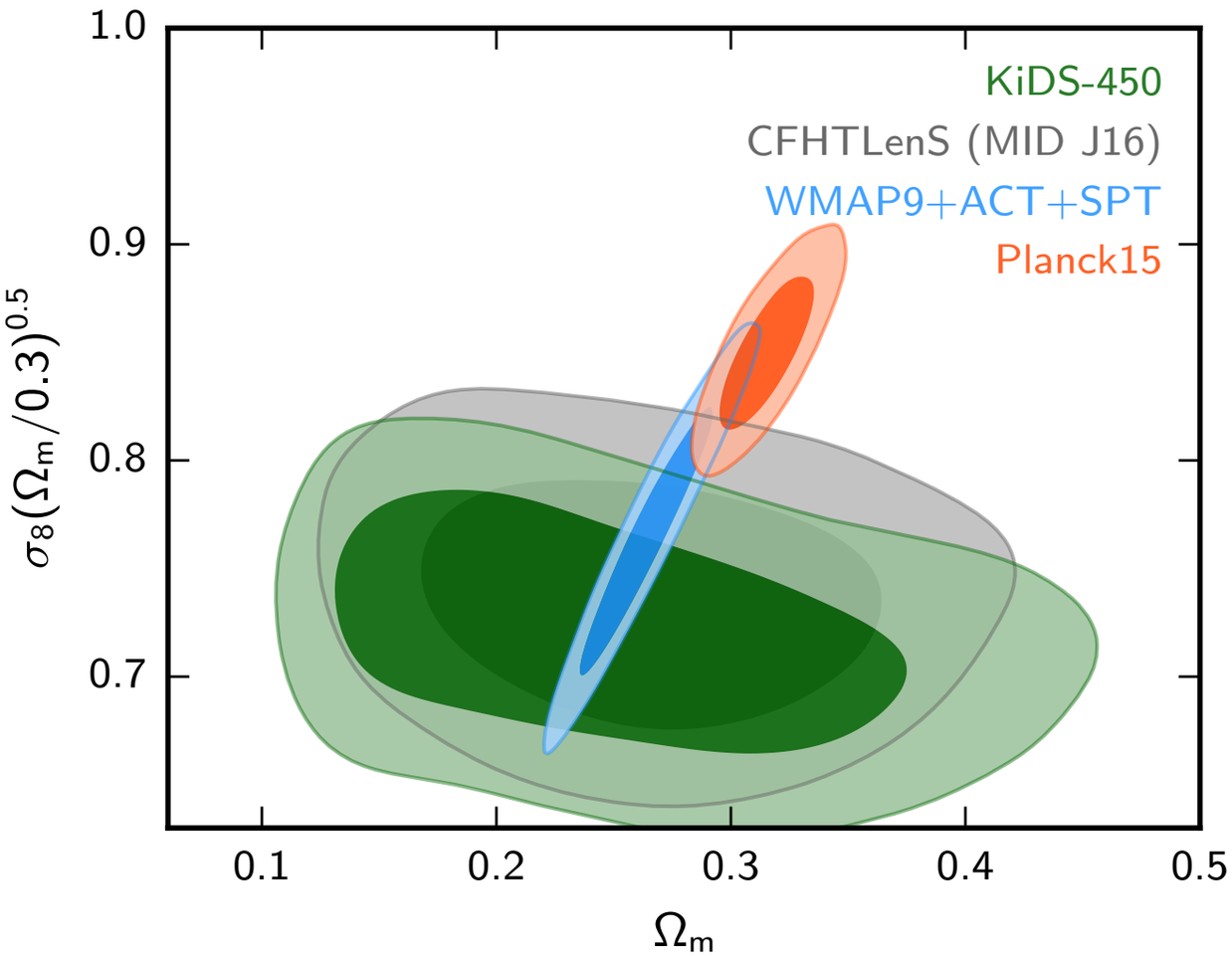


- S_8=0.745±0.039 2.3σ discrepancy with Planck

Hildebrandt, Viola et al. (2017)

KiDS-450: Results (blind-2)

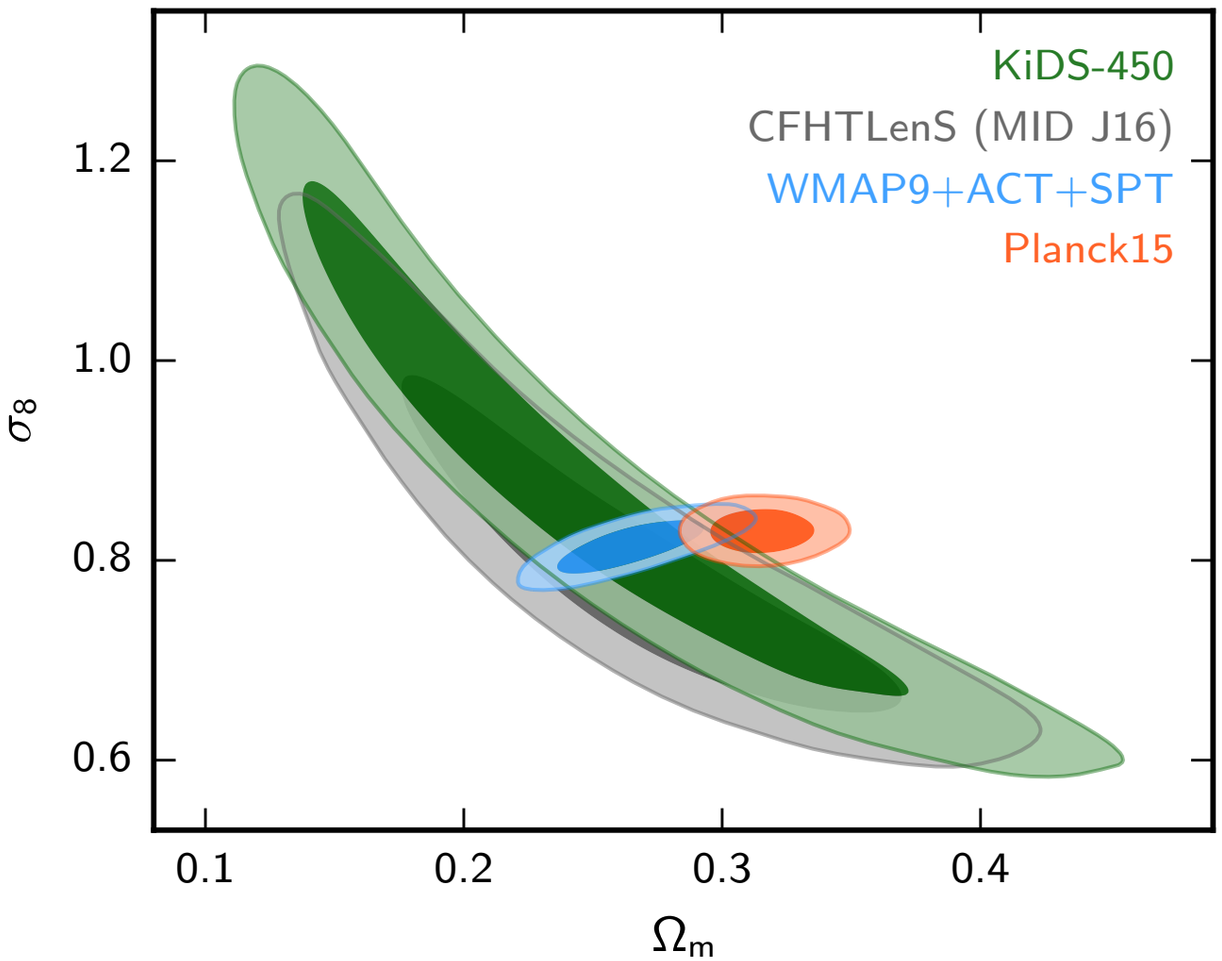


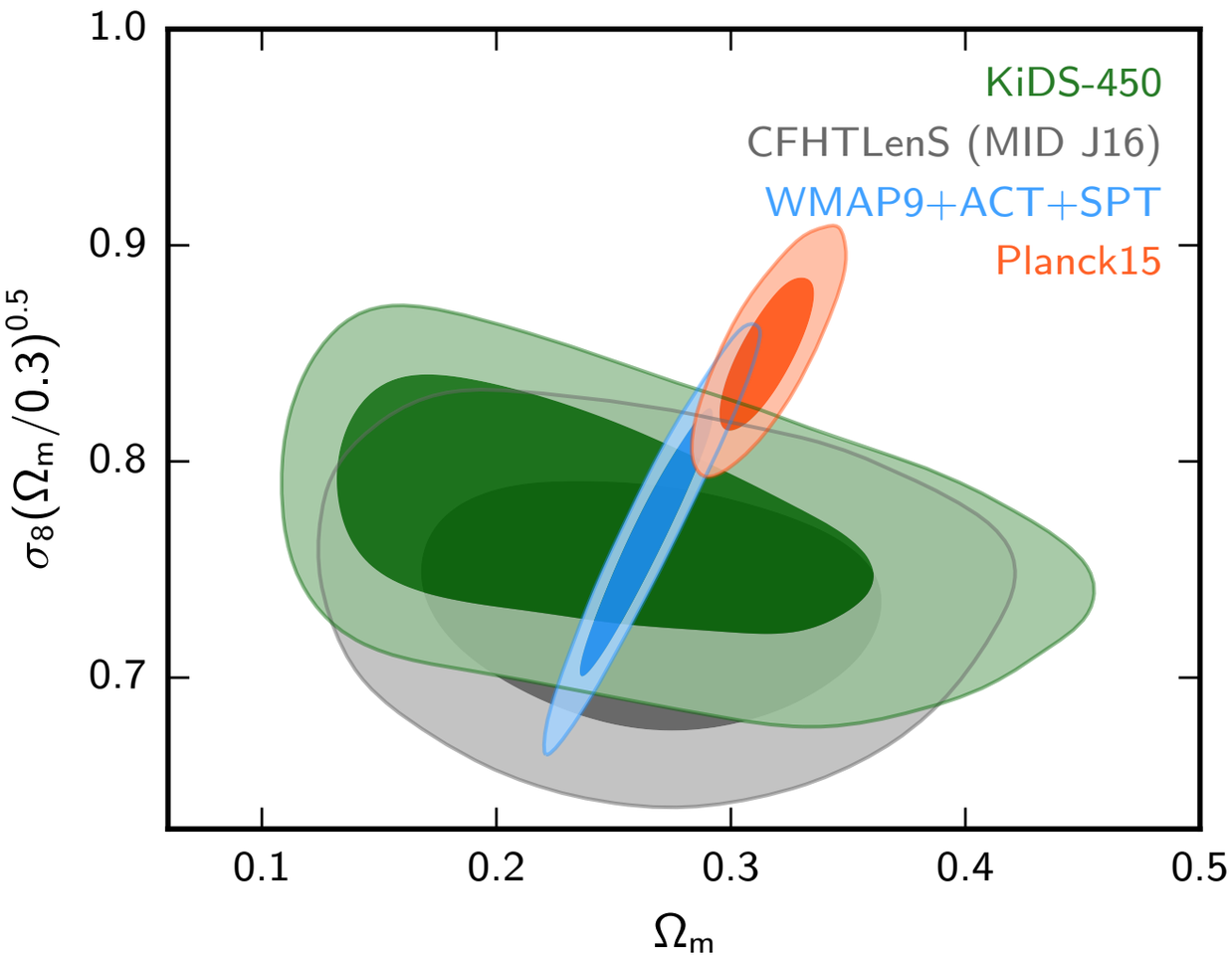


- S_8=0.720±0.039 2.8σ discrepancy with Planck

Hildebrandt, Viola et al. (2017)

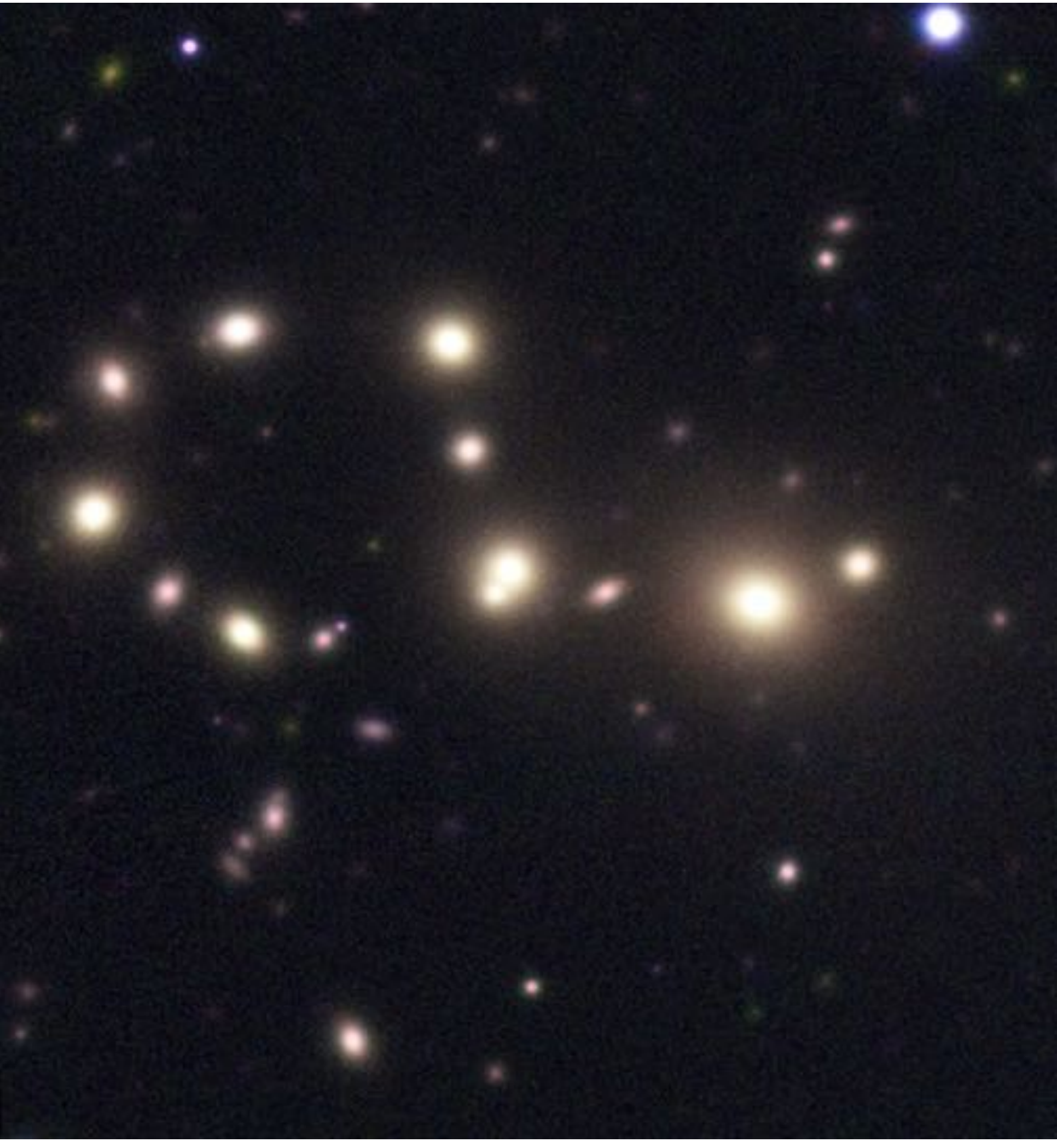
KiDS-450: Results (blind-3)



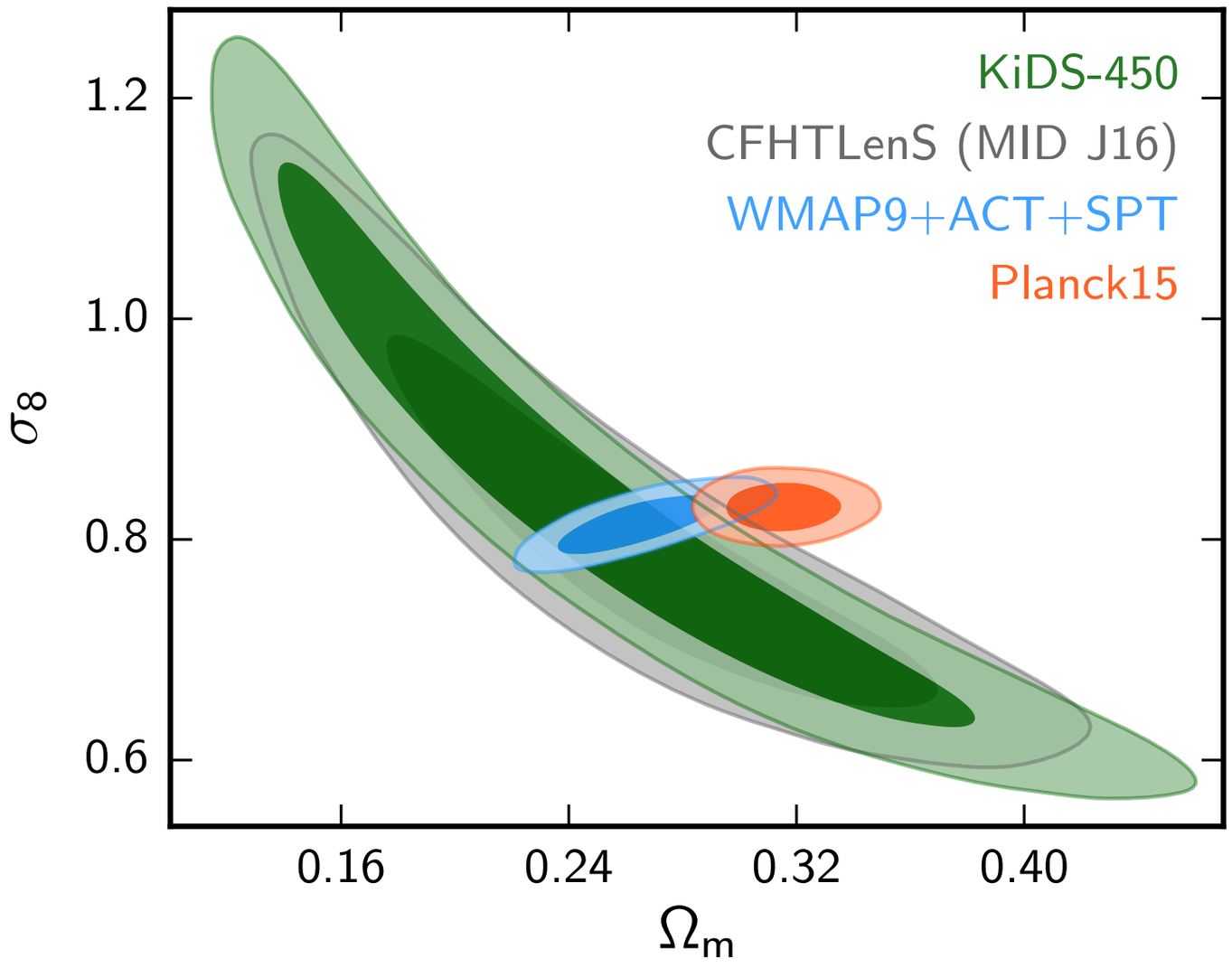


- S_8=0.772±0.039 1.7σ discrepancy with Planck

Hildebrandt, Viola et al. (2017)



KiDS



Result

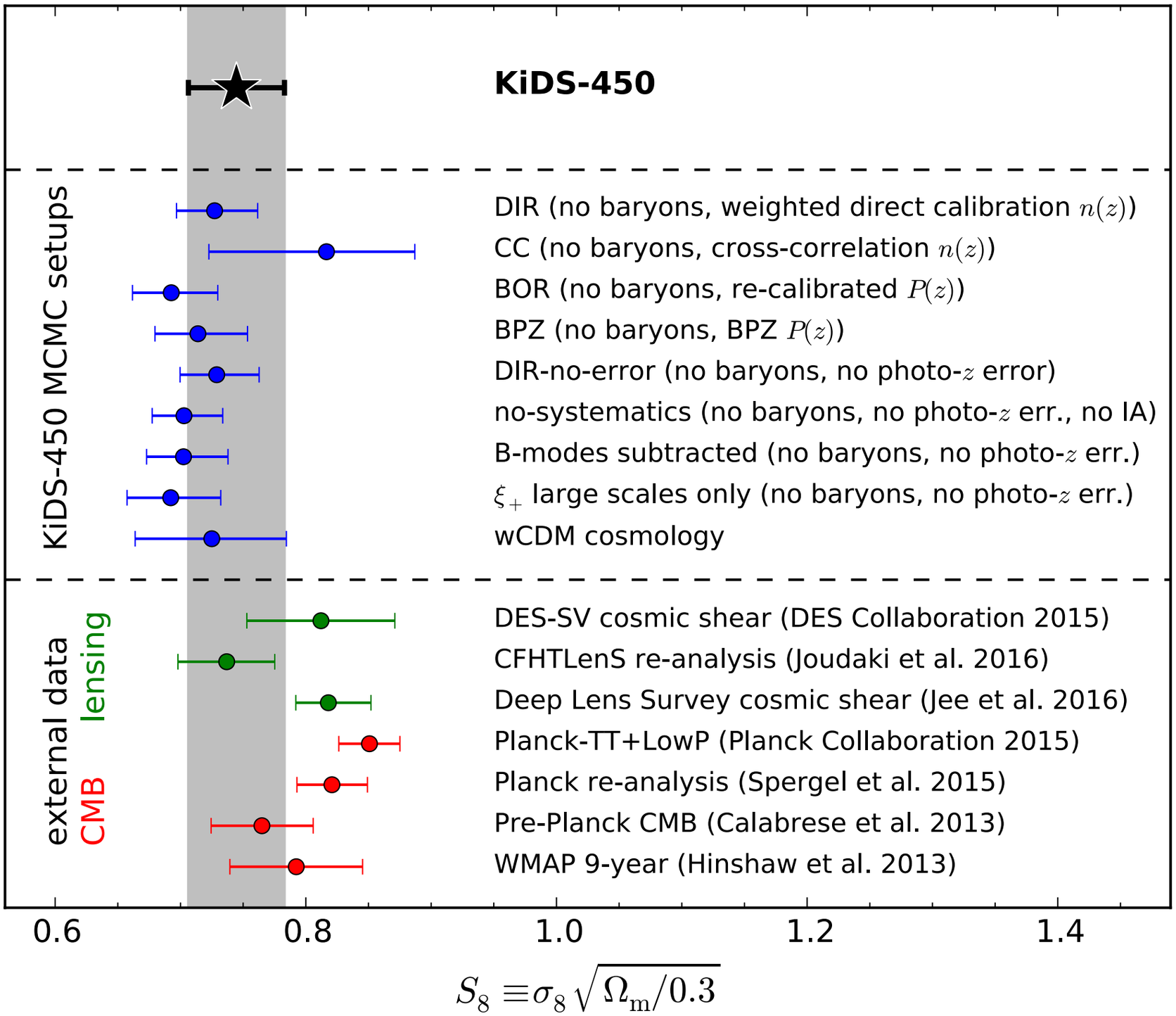
$$\sigma_8\sqrt{(\Omega_m/0.3)}=0.745\pm0.039$$

Systematics error as big as statistical error (0.027)

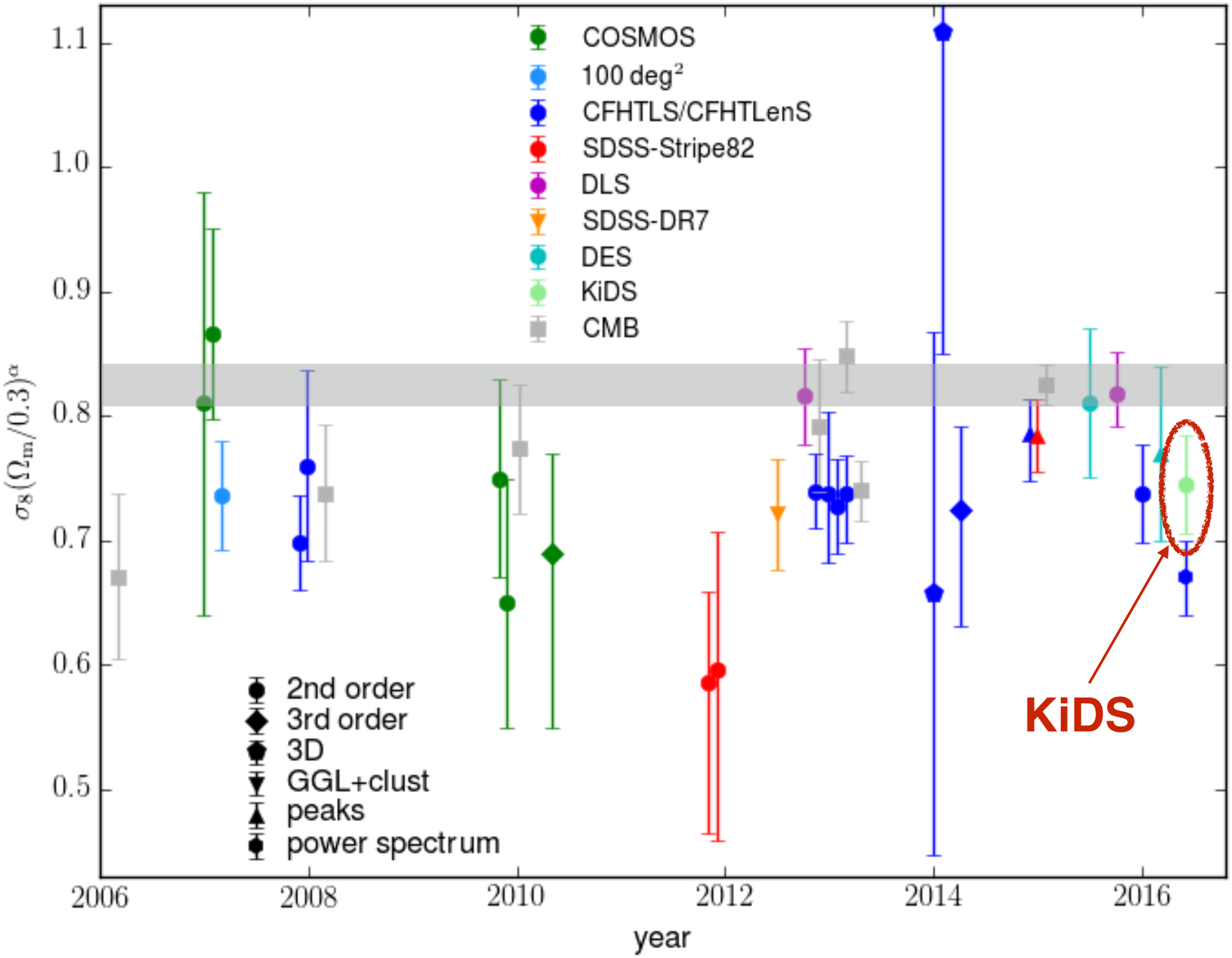
- S_8 constraint very similar to CFHTLenS, pre-planck CMB
- Tension with Planck — $2.7\sigma_{KiDS}$ in S_8
  (2.3σ discrepancy in full parameter space)

Hildebrandt, Viola et al. (2017)

Full results for S_8



Hildebrandt, Viola et al. (2017)



S_8 results over the years

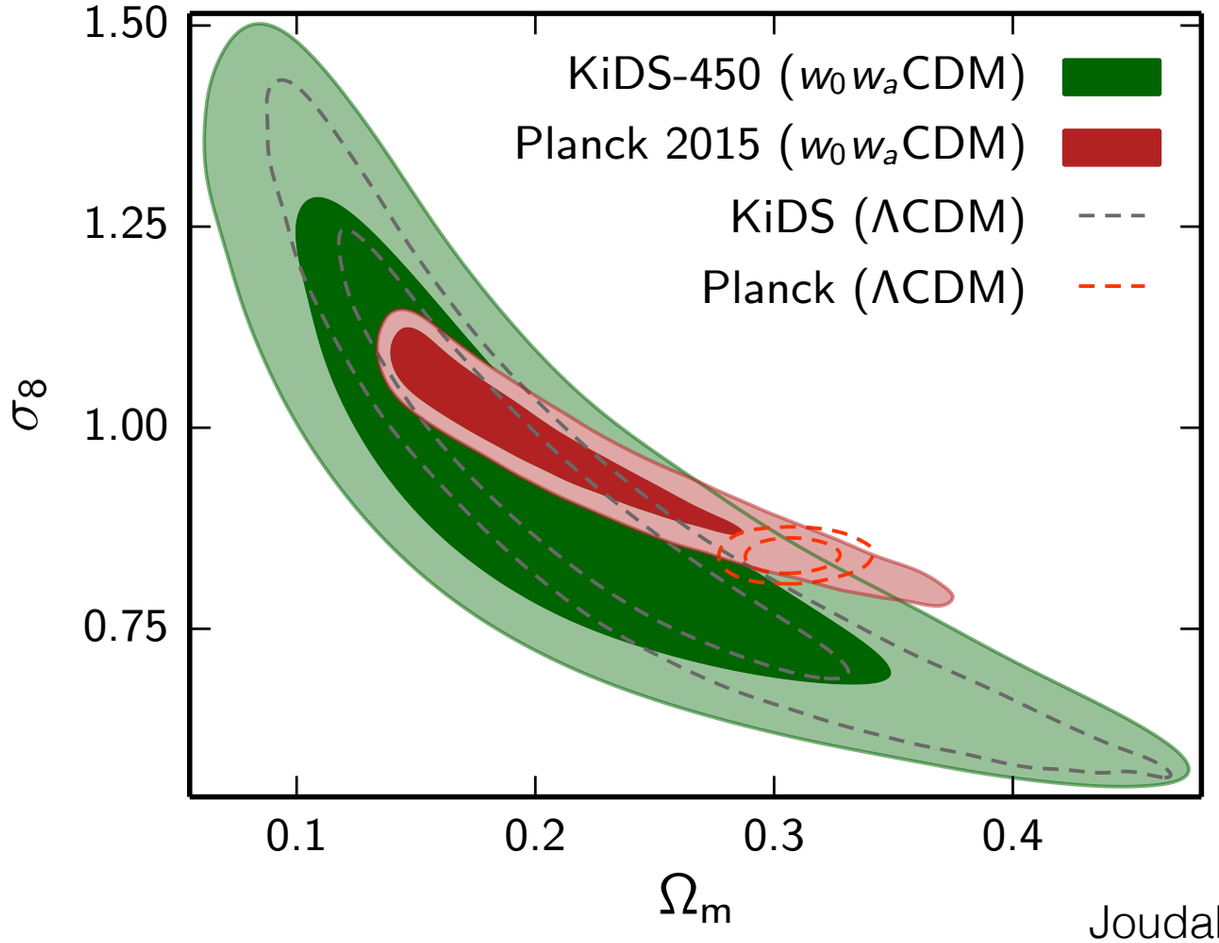
Kilbinger (2015; updated)

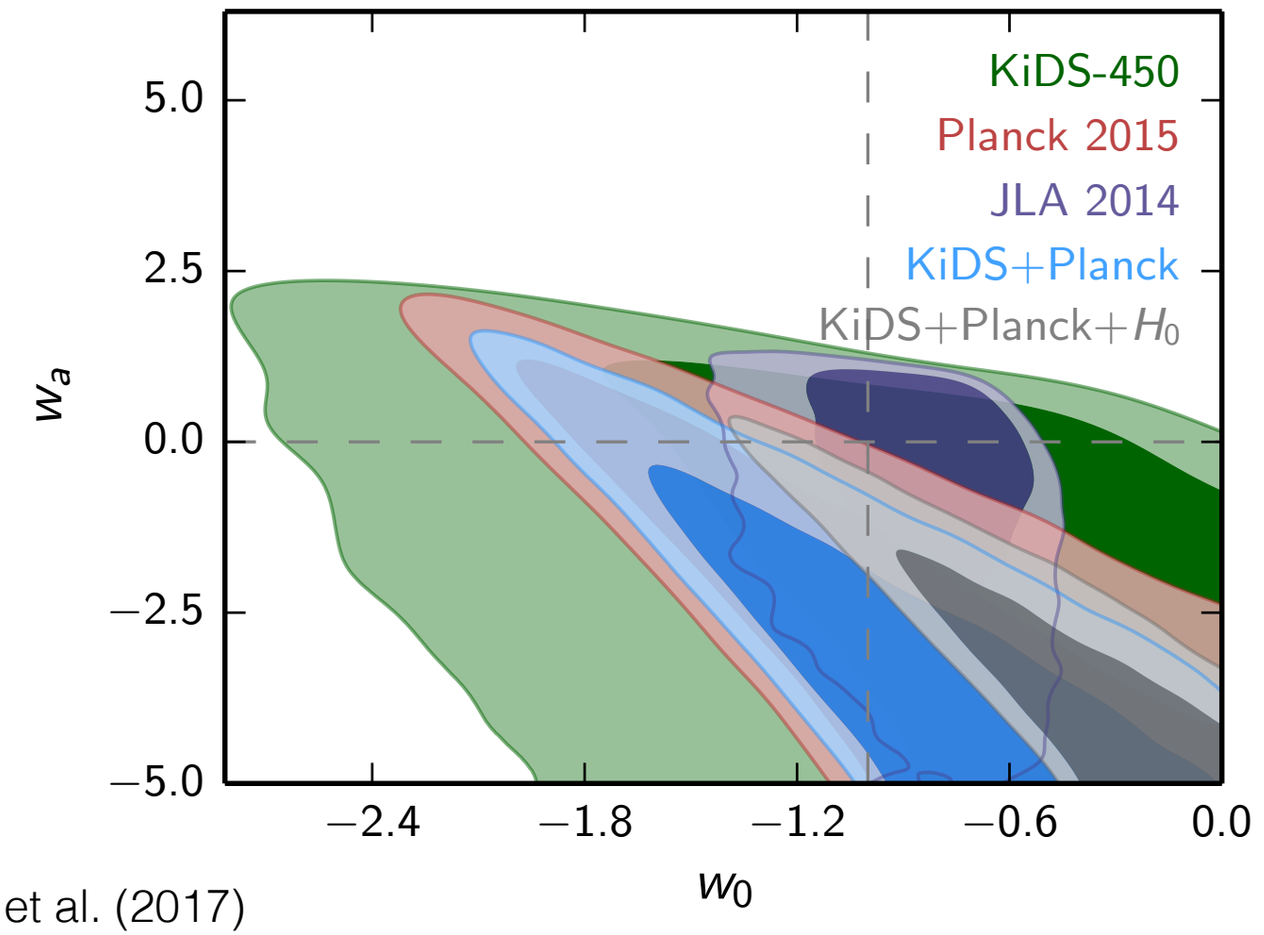
Extended cosmologies

- Massive neutrinos.
- Non-zero curvature.
- Evolving dark energy.
- Modified gravity.
- Running spectral index.

Joudaki et al. (2017)

Evolving dark energy





Joudaki et al. (2017)

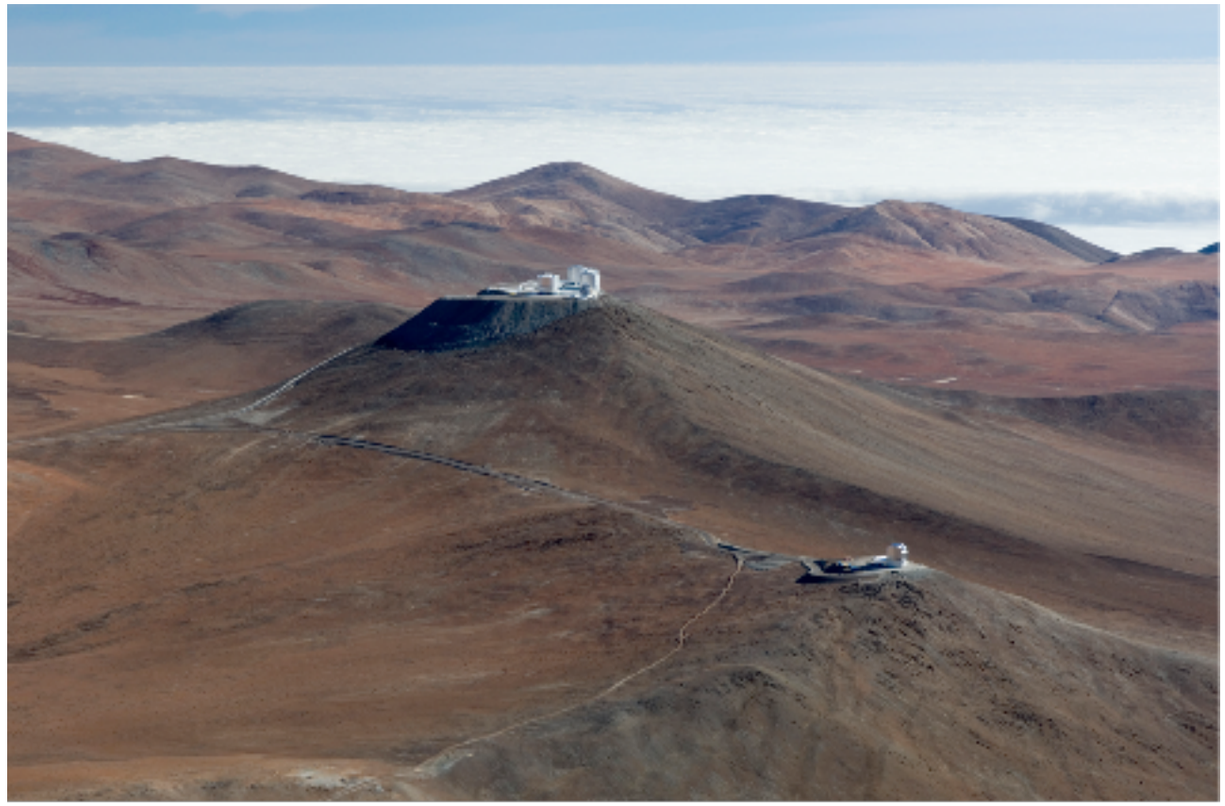
- Resolves tension between KiDS and Planck.
- Only extensions that is moderately favoured by the data.
- 3-σ deviation from a cosmological constant.
- Resolves tension between Riess et al. (2016) and Planck.

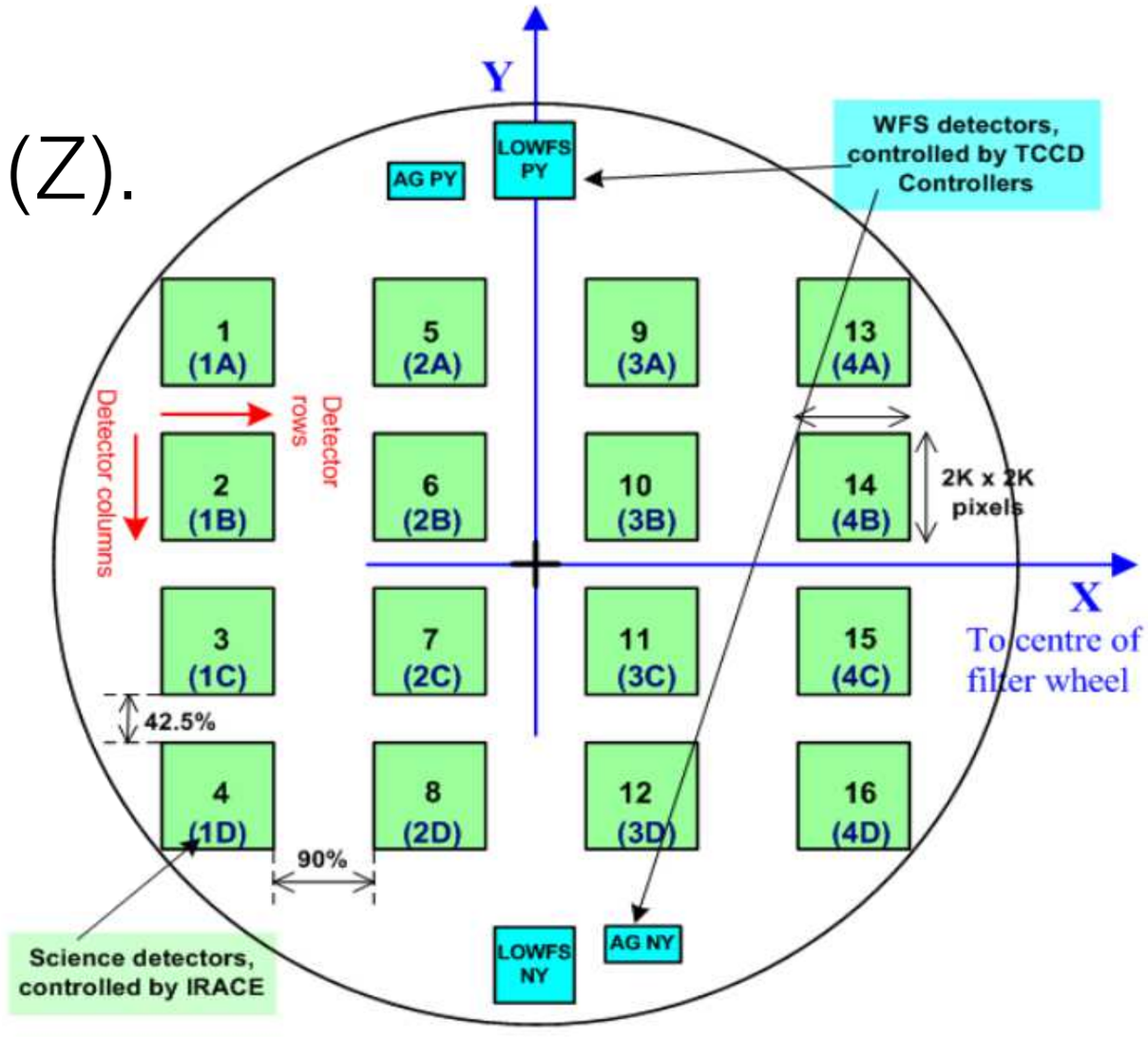
Next steps

- Next KiDS cosmology science projects:
  - Cosmic shear fourier analysis (Köhlinger et al. 2017)
  - Peak statistics (in prep.)
  - Cross-corr. with CMB lensing (Harnois-Déraps et al. 2017)
- Technical work:
  - Understand B-modes with COSEBIs
  - **Photo-z; integrate VIKING data and more spec-z**

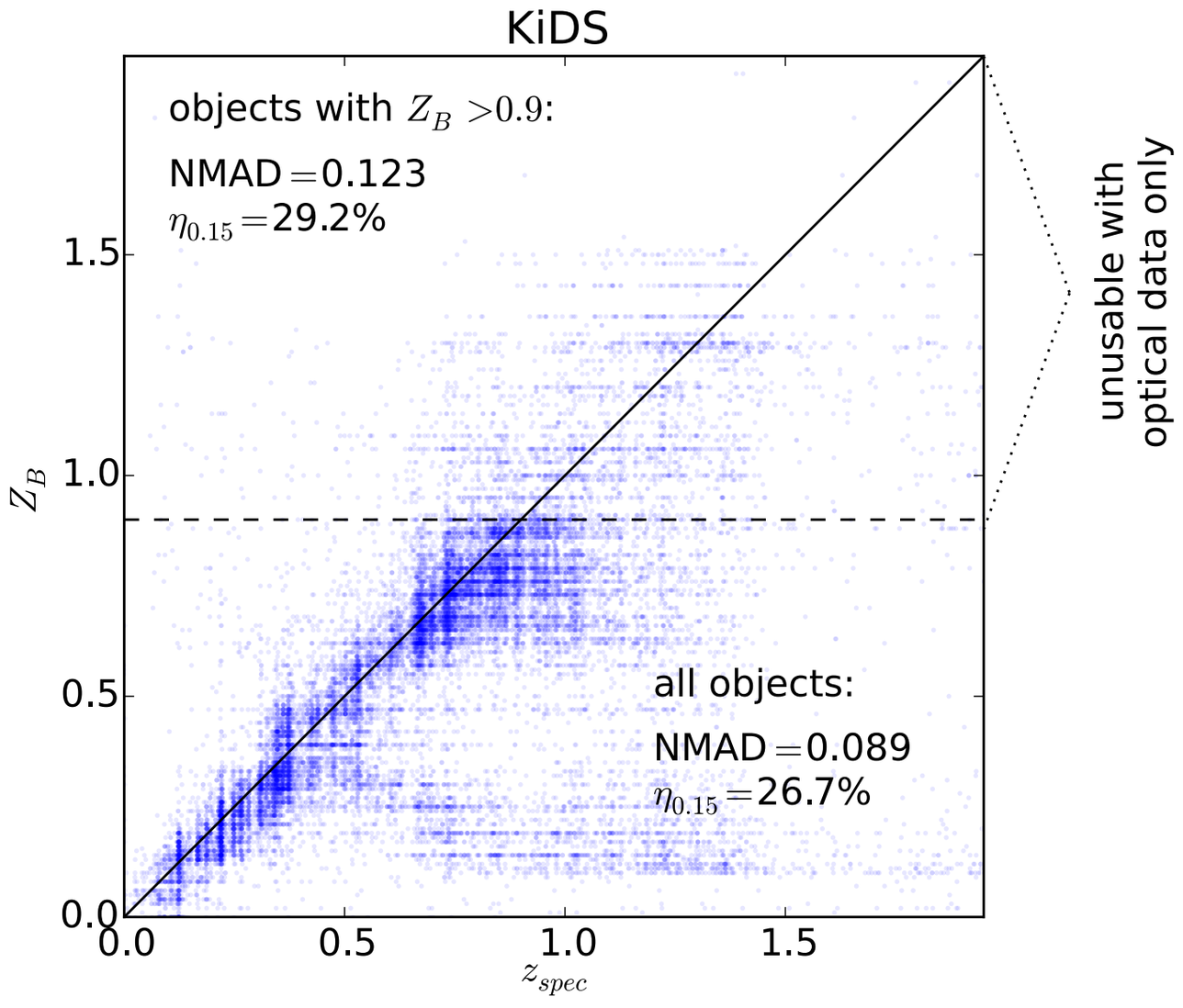
VIKING@VISTA

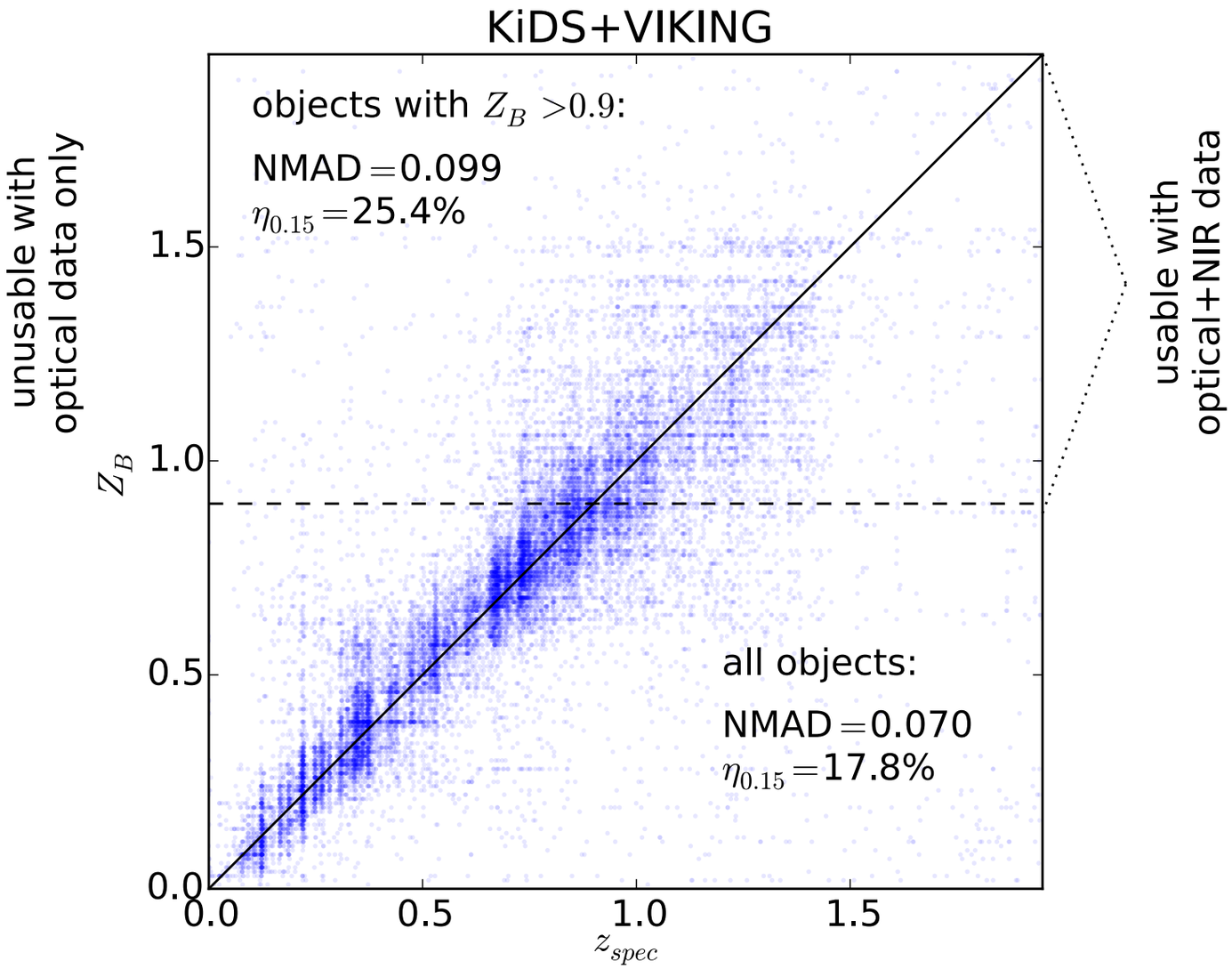
- Same footprint as KiDS.
- Already finished (1350deg^2).
- ZYJHKs images.
- 5σ depths of 21.2 (Ks) to 23.1 (Z).





Photometric redshifts





Cosmic shear at high-z

- 5th tomographic bin with Z_B>0.9.
- ~1 gal/arcmin^2 (15% of all KiDS galaxies).
- High signal, large volume.
- Decrease S_8 error by ~20%, i.e. 3% error on S_8.
- Z_B>0.9 galaxy ~2.5x as valuable as average galaxy!
- **Need to understand redshift and shear calibration!**

Summary & Outlook

- KiDS-450 measures S_8 with ~5% error (1/2 syst., 1/2 stat.).
- Tension Planck versus lensing persists (~2.3σ).
- Emphasis on robustness, redundancy, blind analysis.
- All data public:
  http://kids.strw.leidenuniv.nl/cosmicshear2016.php
- Cosmic shear result tested further from many different angles.
- KiDS+VIKING ~850deg^2 now, 1350deg^2 by end 2018
  => factor >2 improvement in error to robustly test ΛCDM..
- Requires excellent calibration data (ESO LP, Keck, VISTA).
- Lots of other KiDS science (GGL, cross-corr., multi-probe, photo-z, etc.).